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Ponderosa Pine
Working Plan

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COMPARISON OF ROOT DEVELOPMENT OF NATURAL AND FIELD PLANTED PONDEROSA PINE SEEDLINGS

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INTRODUCTION

In the granitic soil province of central Idaho, repeated plantings of ponderosa pine nursery stock have resulted in both poor survival and poor initial growth. It is argued that the unsatisfactory performance of planted seedlings is due primarily to the failure of the root systems to recover from the "traumatic shock" of root pruning as well as other injuries sustained in transit and in planting. This remains a moot question inasmuch as specific information on root development of field planted ponderosa pine nursery stock on granitic soils is not available at least in published form. Because a thorough knowledge of root growth, habit, and physiology appears essential to the success of future planting programs in this region, every effort should be made to understand all these phases of root activity as fully and as soon as possible. The purpose of this study is to compare the development of planted ponderosa pine seedlings to that of natural seedlings growing side by side on the same site. This study will naturally not answer all the questions, touching only one phase, and that only in a small way, but nevertheless it should yield substantial information on comparative performance of the artificial and the natural seedlings under the conditions described herein.

PAST WORK

On the general topic of plant roots there is a voluminous amount of literature.[1/] Forestry literature alone contains numerous articles on roots, the majority of which deal largely with morphology of mature trees, or have been directed at the comparison of form and development of root systems in different species, or of juvenile root systems grown under artificial conditions. Aside from suggestions on technique, such studies have little bearing on the present problem under investigation. Very little data are available on ponderosa pine roots, and none has been published showing development of natural and planted seedlings within the granitic soil province of Idaho. The need for information on this phase is, therefore, particularly acute.

OBJECT OF EXPERIMENT

In general, the object of this experiment is to compare the morphology and growth of natural and planted seedlings. More specifically, the study aims to find out what differences are exhibited in root depth, and form, in root and top size, and in volume of soil occupied by 2-0 ponderosa pine nursery stock and 1-year-old natural seedlings at the beginning of the second growing season on a recent burn.

EXPERIMENTAL PROCEDURE

A. Hypotheses: The form and growth of natural seedlings on a given site may be considered as the paragon of "normal" development for

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1/ Stevens, C. L. 1931. Root Growth of White Pine. (Pinus strobus L.) Yale University Forestry Bull. #32, pp. 62.

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that site. Comparison of planted stock with natural ones growing on the same site should afford a measure of characteristic differences which are thought to exist as a result of artificial treatments.

It may well be that surviving planted seedlings show no significant differences in development when contrasted to natural stock growing under identical conditions. If this is true, then the possibilities for increasing survival on plantations lies largely in the direction of prudent selection of planting sites and better planting technique; if, on the other hand, it proves out that even the best of surviving seedlings fail to develop normally or to recover rapidly enough or adequately enough from the injuries associated with transfer from seedbed to planting site, then hope lies primarily in the selection of planting stock of more suitable form and in the development of hardier strains.

From an experimental standpoint it is perhaps more orthodox and acceptable to assume at the beginning that no differences exist between the natural and the planted seedlings.[2/] It is then left up to the facts gleaned from the experiment to sustain or disprove this null postulation.

b. Variables involved: The only obvious variable in this experiment is source of stock, i.e., natural versus nursery. Strictly speaking, comparability is somewhat impaired owing to the fact that the natural seedlings spring from an indigenous seed source (Elk Creek, Boise Basin) whereas the planted seedlings originate from Bitterroot seed, germinated and grown to 2-0 size in the Savenac Nursery at Haugen, Montana. The

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2/ Fisher, R. A. 1936. Design of the Experiment. Oliver and Boyd. Edinburgh. 2nd edition.

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other point of incomparability is that of age: When this study is executed (early June 1936) the natural seedlings will be only slightly more than a year old whereas the planted seedlings will be starting on their fourth growing season, their second in the field. Both shortcomings are unfortunate, but unavoidable in this case.

Site variation will be controlled by sampling only on one aspect (the northeast) and restricting the selection of sample seedlings to a locality within which competition is of an apparent uniform density.

While time variation will be controlled by digging both a natural and a planted seedling in the same day, this is hardly necessary since expected time lapse for completing the job is only about 5 days, this being not sufficient to introduce big differences in growth between the first and the last seedling dug. In fact, the influence of local soil variation is probably so important as to completely obscure any differences that might accrue from growth alone.

c. Design of the experiment and scheme of analysis: Inspection of the 1935 data on roots of natural seedlings indicated considerable variation between aspects and even within aspects. The variation was so large in fact that reduction of data by statistical methods was deemed inadvisable except where the number of observations happened to be large. In the present case, however, it is believed that the principles of random sampling can be applied, and the validity of the findings enhanced thereby simply by restricting the sampling to a small area of apparent comparability insofar as site factors are concerned.

The actual sampling will be done in the following fashion: Within the sample area temporarily number all planted seedlings and

also all natural seedlings, each group designated by a separate series. Then draw at random 10 seedlings from each group. This number is deemed sufficient to give reliable mean values in view of the limitations imposed on chances for variation in site quality. In fact, if it does not, then the differences between groups could hardly be construed as important even if proven statistically significant by employment of larger samples.

This scheme of sampling will validate use of analysis of variance to test significance of differences in the various measured data between groups.[3/] The following table indicates the sources of variation:

Table 1.- Sources of variation in several sets of measured data (root length, root weight, etc.) from natural and planted ponderosa pine seedlings. Elk Creek burn, central Idaho. 1936.

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	19		
Between Groups	1		
Within groups (error)	18		

If the ratio of the larger mean square to the smaller mean square exceeds 4.41 for any given set of measurements the differences between groups may be considered significant (provided of course that the larger mean square is for the "between group" source); likewise, if greater than 8.28, they may be considered highly significant.

3/ A more sensitive measurement of differences might have been obtained by "pairing" natural and planted seedlings so as to decrease still more the variation in site, microclimate, etc. The group comparisons, however, should give a more general picture, possibly of wider applicability.

d. Basic data required: For the purpose of obtaining a good picture of the planted and natural seedling development, the following basic data appear essential:

1. Length of tap root to nearest tenth inch.
2. Length of laterals " " " "
3. Volume of roots to nearest 1/10 cc.
4. Volume of top to nearest 1/10 cc.
5. Volume of new top (1935 season) to nearest 1/10 cc.
6. Oven-dry weight of roots to nearest milligram.
7. Oven-dry weight of new top (1935 season) to nearest mg.
8. Oven-dry weight of top to nearest milligram.
9. Length of top from ground surface to bud recorded in inches and tenths.
10. Length of new top (1935 season) to nearest 1/10 inch.
11. Volume of soil occupied by roots (in cubic inches).
12. Area of projected roots in square inches.

e. Method of obtaining basic data: Both field and laboratory work will be necessary for obtaining all the essential figures. The laboratory work involved is standard procedure and is suggested in section (d). The field procedure will require a little elaboration. Each seedling previously located by random selection will be carefully removed by digging and washing. In the actual field technique, a #18 iron wire will be stretched at the ground surface to divide the probable lateral zone of the roots into north, east, south, and west quadrants, with the seedling at the origin, and then the soil will be carefully removed by the aid of a trowel, an ice pick, and water from an automatic

spray pump. The number and length of laterals over six inches long, and/or also shorter, rapidly growing laterals for each 6-inch depth zone within each quadrant will be recorded. Likewise, the area occupied by these roots when projected to the bottom of the 6-inch zone, and the estimated volume of soil occupied by them will be recorded. In estimating this volume of soil, a lateral root with $\frac{1}{2}$-inch sublaterals, for example, will be considered as occupying a cylindrical volume one inch in diameter.

The total depth penetrated by the roots of each seedlings will be recorded to the nearest tenth inch. The maximum depth will be used in each case whether this maximum be of a lateral or tap.

f. Costs: It is estimated that the field and laboratory work will take two men 5 days to complete. Compilations and calculations and report preparation, 1 man 15 days. Total man-day requirements about 25 to 30 days.

g. Responsibility: Junior Forester Wayne B. Read and assistant.

h. Time of study and completion: Field work, June 1-10, 1936. Preliminary report - winter of 1936-1937. Final report - indefinite.